Atomic Energy Control Board
P.O. Box 1046
Ottawa, Canada
K1P 5S9

Commission de contrôle de l'énergie atomique
C.P. 1046
Ottawa, Canada
K1P 5S9

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AECB STAFF REVIEW OF BRUCE NGS 'A' OPERATION FOR THE YEAR 1988

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Canada

Report

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1. INTRODUCTION

The operation of Bruce NGS"A" is monitored and the licensing requirements are enforced by AECB project staff resident at the station. To assess operation in accordance with licensing requirements, the project staff, with appropriate support from other AECB personnel, monitors operation of the four reactors, witnesses important activities, conducts audits, carries out inspections, and reviews station documents and licensee's reports as appropriate.

To comply with the requirements of the licence, Ontario Hydro issues Quarterly Technical Reports which summarize key features of station operation during the year. Following AECB staff review of these reports and preparation of the AECB Staff Review of Station Operation in draft form, a formal Annual Review Meeting is held with the station management and senior staff to discuss safety-related issues and to convey to Ontario Hydro the AECB's assessment of station operation during the year.

This report presents AECB project staff's review of major licensing issues and of the operational performance of the station during 1988. Ontario Hydro reports and official correspondence and observations of AECB staff at site have been taken into consideration. The report is limited to aspects of the station performance that AECB staff considers to have safety significance. Where significant developments associated with issues addressed in the report occurred in the early part of 1989 (up to the time of writing), these are mentioned.

2. STATION OPERATION

2.1 Station Performance

The station net capacity factor for 1988 was 58.68%. This compares with a "since in-service" average capacity factor of 79.48% and last year's 64.98%. The below-average value was once again primariiy due to lengthy unit outages. Another significant contribution in 1988 was the restriction on Unit 2 power level to 80% or less for most of the year due to boiler level oscillations[1].

The following major unit outages occurred during the year:

Unit 1

88-02-27 to 88-04-17 (50 days)	-	Biannual outage for inspection/maintenance and installation of safety system design changes

Unit 3

88-06-22 to 88-12-31 (190 days)	-	West Shift Outage (to adjust fuel channel positions to permit further creep growth of pressure tubes) plus major maintenance and inspection of pressure tubes

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Note 1: Boiler level oscillations are discussed in more detail in section 2.2 below.

Unit 4

88-01-01 to 88-02-25 (56 days)	-	Biannual outage for inspection/maintenance plus major repairs to heat transport system valves
88-09-02 to 88-10-21 (50 days)	-	Vault vapor recovery damper installation and repairs to moderator heat exchangers

Units 1 and 2

88-09-29 to 88-10-09 (10 days)	-	Shutdown of operating units to avoid licence violation (failure to install "P Trip" by 88-09-30) **Note:** Units 3 and 4 were already shutdown for other reasons.

With Bruce NGS"B" fully operational, transmission line limitations again contributed significantly to the low capacity factor. These limitations are expected to continue adversely influencing Bruce NGS"A" performance until late in 1990 when the 500 KV transmission line, presently under construction, is expected to be in-service. The availability of this additional line will allow all the Bruce units (NGS"A" and NGS"B") to export their full power capacity to the grid.

The forced 10 day outage of Units 1 and 2 at the end of September was a result of AECB action in rejecting Ontario Hydro's request for an extension to the September 30, 1988 deadline for placing in-service a permanent automatic heat transport pump trip (P Trip) system. Following review of an Ontario Hydro proposal to effect improvements to the P-Trip design and to complete installation and commissioning of the new system by the end of March 1989, AECB staff authorized resumption of normal operation of the reactors on October 8, 1988 for the duration of the prevailing operating licence period (up to end of October 1988).

2.2 Unit Operation at High Power

Throughout the report period, all four units were licensed to operate at full power. However, as a result of limitations in the capacity of the transmission lines from Bruce site, very little operation above 95% full power took place on any unit. There was, therefore, little opportunity to fully assess the effects of corrective measures implemented by Ontario Hydro to resolve problems associated with high power operation that were reported in the 1986 and 1987 Annual Reports. However, AECB staff believes that the problem associated with control of spatial flux disturbances is now satisfactorily resolved (see Section 3.1.1 in the AECB Report for 1987 Station Operation). Progress with respect to the other identified problems is reported below.

Low Frequency Oscillation

Low frequency oscillation of major unit operational parameters such as reactor power, heat transport pressure, pressurizer level, heat transport feed and bleed flow rates, was reported in the last two AECB staff Annual Reports. The design modification to pressurizer level control, reported last year, has been completed on the remaining units but commissioning has yet to be completed on Unit 3. This has been delayed because opportunities to operate the unit at 100% F.P. have been limited. On the three units on which the design change has been commissioned, the oscillations have been effectively reduced and no longer threaten control stability at high power. However, as was required on Unit 2 in 1987, extensive tuning of the controllers and amplifiers in the pressurizer level control circuit was necessary on Units 1 and 3 also and further adjustments will probably be required in the future as the thermohydraulic characteristics of the heat transport systems change.

Boiler Level Oscillations

The probable cause of the oscillations in the water level indication on boiler #3 of Unit 3 has been found. It is blockage of the tube penetrations in the upper boiler tube support plates. There are seven tube support plates and the holes through which the boiler tubes penetrate in the uppermost two (support plates 6 and 7) are severely blocked. A fiber-optics inspection revealed that some of the penetrations in the top support plate were completely blocked and that the average blockage of the tube penetrations in this plate on the "hot leg"[1] side of the boiler was more than 50%. Blockage of the holes in lower support plates was found to be less severe.

This phenomenon prevented Unit 2 from being operated at full power throughout the report period. From July 1988 until the end of the year, power was restricted to less than 75%. Towards the end of the year, oscillations began to show on boiler #6 of Unit 1 and as for Unit 2, became progressively more severe. At the time of writing, the maximum power level of Unit 1 is restricted to 82%.

Ontario Hydro has developed a plan to deal with this problem which involves, initially, temporary mechanical cleaning and, finally, chemical cleaning, of the boilers to remove the scale causing the blockage. The initial stage of the plan will employ one of two techniques for scale removal, 'water lancing' or 'water slap' (also referred to as 'hydro impact'). The first technique, which is the preferred one, will be tried initially and only if unsuccessful will the second technique be tried. It is intended to clean all eight boilers in Unit 2 using one of these techniques during the planned unit outage in 1989 and also to clean all Unit 1's boilers using the chosen technique during the planned outage of this unit later in 1989.

Note 1: "Hot leg" - heat transport fluid inlet (side of the boiler).

If the water cleaning process is successful, the operational constraint on full power operation of units 1 and 2 due to boiler level oscillation will be removed. The same water cleaning process will be used to clean the boilers on Units 3 and 4, if necessary, should boiler level oscillations occur before a chemical cleaning process is available. Ontario Hydro expect to have `chemical cleaning' available for use in 1992. AECB staff has assessed the impact of both water cleaning techniques on the structural integrity of the boilers and is satisfied that neither process involves significant risk. The program will be closely monitored during its implementation.

3. AECB STAFF REVIEW OF OPERATIONAL SAFETY ASPECTS

3.1 Station Compliance

3.1.1 Compliance with Regulations

AECB staff considers that, with respect to Bruce NGS"A", Ontario Hydro complied with the relevant regulations during 1988.

3.1.2 Compliance with the Licence

Ontario Hydro has generally complied with the conditions of its reactor operating licence (ROL 10/86 until 31 October 1988 and subsequently ROL 8/88) with some exceptions which are discussed below:

3.1.2.1 Compliance with Operating Policies and Principles (Condition A.A.1)

Nine events were reported which represented breaches of the Station Operating Policies and Principles. These events are discussed further in section 3.7.

3.1.2.2 Compliance with Ontario Hydro's Radiation Protection Regulations, Part 1 (Condition A.A.1)

AECB staff's review of the radiation control related significant events reported in 1988 concluded that none of them represented a breach of this condition. Also, there were no incidents of personnel receiving doses in excess of regulatory limits, although in the case of the "hot particle" incident (see section 3.3), evidence is circumstantial.

3.1.2.3 Maintenance (Condition A.A.11)

As discussed elsewhere, (sections 3.9 and 4.1.5) in this report and in last year's report, AECB staff was not satisfied that maintenance standards at Bruce NGS"A" for 1988 were such as to meet the licence condition -

"A.A.11 Maintenance at the nuclear facility shall be of such a standard that, in the opinion of the Board, the reliability and effectiveness of all equipment and systems as claimed in the Safety Report and documents listed in the application are assured."

It is recognized that Ontario Hydro is taking steps to rectify the situation and AECB staff is monitoring these closely.

3.1.2.4 Testing (Condition A.A 13)

While Bruce NGS"A" has a good record of completion of safety system tests, in April it was discovered that an administrative error resulted in only one of three channels being tested for one feature associated with shutdown system number two (SDS2) for a significant period of time. Subsequent testing indicated that the system had not been impaired but there clearly was a breakdown in the testing program.

3.1.2.5 Installation of Primary Heat Transport Trip

Failure of Ontario Hydro to install a permanent pump trip facility by 30 September 1988 was a very significant licensing event. Further details are provided in section 4.2 of this report. In placing the reactors in an approved condition before the stated deadline, Ontario Hydro did, however, technically avoid committing a licence violation.

3.1.3 AECB Staff Comment on Compliance with Bruce NGS"A" Reactor Operating Licence During 1988

It is apparent that station management made a determined effort to comply with licence conditions in 1988. All of the technical breaches of licence conditions reported above were inadvertent and appropriate steps were taken to prevent reoccurence. Improvements were observed, relative to 1987, in timeliness of technical report submissions, and expeditious completion of reports, tests, inspections, modifications, and analyses requested by the Board (Condition A.A.12). The latter area is still constrained by resources but Ontario Hydro is now seriously attempting to meet its commitments and to keep AECB staff regularly informed of progress.

3.2 Quarterly Reports

AECB project staff has reviewed the four Quarterly Technical Reports submitted by the licensee covering station performance during 1988. These documents contain detailed information on performance of the station reactor units, the safety systems and safety-related activities such as chemical control, radiation control, and handling of prescribed materials. In addition, the reports contain safety reliability assessments, fault data and predictions for future unavailability of safety systems. In their review, AECB staff found the reports to be clear in content and as far as could be judged, accurate records of station performance and events.

Two additions were made to the Quarterly Report contents in 1988:

1) "The Primary Heat Transport Pump Trip System" was added to the "Standby Support Systems" section of Part 9 "Reactor Safety Reliability Assessment".

2) A table listing and classifying safety system faults was added to Part 1 "Summary" of the fourth quarter report. This addition was made at the request of AECB project staff and shows the fault classification initially assigned by the shift supervisor and the final classification after analysis of the incident.

The table lists a total of eighteen faults on the four special safety systems (SDS1, SDS2, Containment and Emergency Coolant Injection [ECI]), plus "P Trip". In two cases, the final analysis showed the fault to have been more severe than was first believed by the shift supervisor, and in one case less severe.

3.3 Radiation Protection

There were no known whole body exposures of station personnel in excess of the legal limits during 1988 (but see "hot particle" event below). Accumulated doses for station staff, with the exception of neutron dose, were lower than in 1987. The total station neutron dose was 0.115 rem (1.15 mSv) compared with 0.065 rem (0.65 mSv) in 1987. Although this dose level is not a cause for concern, the increase is noteworthy. It can most likely be attributed to the increase in maintenance work on the moderator systems with the units at power, and to work on reactivity mechanisms and heat transport pump support constraints. The largest reduction in dose levels from 1987 and 1988 is for total extremity dose which dropped from 759 Rem (7.59 Sv) to 551 Rem (5.51 Sv). This is a significant improvement for which effective high hazard work control is largely responsible.

Forty-three supervisor investigations into radiation incidences were carried out during 1988. This is four less than the previous year but nevertheless indicates that lack of adherence to radiation control procedures and such less than satisfactory working practices remain a concern. AECB project staff noted that radiation survey boards posted around the plant were often out-of-date, sometimes by several months.

There were fifteen significant events in 1988 involving radiation control incidents. Nine of these were spills or leaks of moderator or heat transport system heavy water due to a passing valve or improper isolation during maintenance.

A major event involving a 'hot particle' occurred in November. A bag of plastic suits removed from a laundry bin at an access control exit area (Airlock 15) outside containment was reported to have a contact doserate of 700 R/hr, (7 Gy/hr) on contact. The bag containing the source was put in a shielded flask. Rapid dosimetry readout of all personnel known to have been working in the area during the previous 24 hours showed no high dose accumulations. Thirteen employees were initially banned from further radioactive work. Following the initial investigation, this was reduced to six persons who had entered and exited containment via the airlock and who had deposited their plastic suits in the laundry bins. The restriction on these six remained until their potential doses were determined. The assessment of potential doses showed that three of the six could not have been exposed to the source. Of the three remaining persons, two may have exceeded the station extremity quarterly administative limit, and one may have exceeded the quarterly regulatory extremity limit. In parallel with the dose assessments, an in-depth investigation was conducted by non-station personnel at the request of the station Health Physicist. The source was found to be a discrete radioactive particle containing 0.2 Ci of Cobalt-60,

an activation product believed to come from the heat transport system of Unit 3 or Unit 1. The investigation revealed a lack of procedures and training for handling hot particles and weaknesses in existing contamination control and radiation work planning procedures at the station. Recommendations for improvements in these areas are now being acted upon by the station organization. AECB staff has closely monitored this incident and its subsequent investigation and is of the opinion that the investigators recommendations are thorough and appropriate. Nevertheless, it is not satisfied that management has given follow-up actions sufficient priority. Indeed, it appeared to take the threat of a work refusal by operations staff to initiate recommended additional staff training. Further monitoring will be done to ensure that the recommendations are effectively implemented.

3.4 Station Effluents and Environmental Monitoring

Appendix II, Objective Measures, indicates the station gaseous and waterborne emissions and environmental measurements. There were no emissions from the station during 1988 in excess of Derived Emission Limits (DEL). The 1% DEL weekly target limit was exceeded on two occasions for airborne tritium releases[1]. The cause of both these emissions is attributed to confinement drier malfunction. The situation with respect to the station's radiation monitoring facilities, which was reported as unsatisfactory last year, has not improved. Although commitments have been made by the licensee and work is underway to install improved design gaseous effluent monitors and to place in-service the D_2O in H_2O sampling system and also the on-line liquid effluent monitor, these facilities are not yet available. It is the opinion of AECB staff that action to complete the improvements must be given higher priority by Ontario Hydro.

The licensee has submitted to the AECB proposed changes in the station DELs for approval. The changes arose from a re-analysis of emission limits using updated method of calculating dose to the public. The proposal is still under review by AECB staff at the time of writing.

As shown in Appendix II section 1.2.2, environmental measurements compare favorably with 1987.

3.5 Process Systems

3.5.1 Reactor Process Systems

Sixteen (16) of the fifty-seven (57) significant events reported in 1988 pursuant to the operating license involved reactor process systems. These events were diverse in nature and many of them occurred during a unit start-up or shutdown. A significant amount of maintenance (more than in

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Note 1: The DEL (Derived Emission Limit) is a regulatory limit imposed on the release of individual radioactive isotopes from the station over a fixed time period. Ontario Hydro attempts to restrict its emissions to 1% of the DEL.

past years) was carried out on heat transport and moderator system components during the year and an extensive fuel channel inspection program was undertaken on Unit 3 following the 'West Shift' work. Repairs to 'passing' moderator system check valves and moderator and heat transport system control valves have contributed significantly to unit outage time as has inspection and plugging of moderator heat exchanger tubes which have been deteriorating rapidly in service due to pitting corrosion. Ontario Hydro plans to replace these heat exchangers in the future.

There were three significant events associated with the temporary heat transport pump trip (P trip). All resulted in an impairment of the system. In two cases, the cause was an operator or maintainer error, and, in the remaining one, failure of a component in the protective circuit of a heat transport pump motor breaker.

On two occasions in May, heat transport pump seal failure caused a unit shutdown. In both cases, it was a secondary seal failure and the primary seal remained intact.

A delay in replacing a blocked flow meter on the annulus gas system of Unit 4 resulted in impairment of the system's capability to detect pressure tube leaks. With one of forty flowpaths blocked, the unit was without pressure tube leak detection on 12 of the 480 fuel channels for a period of 13 days.

During periodic inspection of Unit 1 maintenance cooling system pipework, some pipework hangers and supports were found to have come loose and to have caused damage to the system piping. In two areas, fretting was found and, in one case, it had penetrated through almost 30% of the pipe wall. Following analysis to confirm sufficient wall thickness, the damaged areas were repaired by grinding to remove sharp edges and hangers, and supports were repaired and provided with locknuts to prevent a recurrence.

To satisfy AECB concerns with respect to assurance of fuel channel integrity following a loss-of-coolant accident (LOCA), the maximum permissible calandria outlet temperature for full power operation was lowered from 72°C to 68°C in April '88. This lower operating limit provides adequate moderator subcooling in the event of a total loss of cover gas pressure following a large break LOCA. This had previously not been allowed for in the safety analysis.

Full length inspection was carried out on 41 selected fuel channels and scrape samples were taken from 20 pressure tubes on Unit 3 for determination of deuterium concentrations. The inspection revealed that none of the pressure tubes had significant flaws and none were in contact with the calandria tube. The scrape sample analysis showed deuterium concentrations and distribution to be within the expected ranges based on pressure tube history and results obtained at Pickering NGS"A" on Units 3 and 4.

Ultrasonic inspection of 166 pressure tube rolled joints and 4 full length channel inspections on Unit 1 in March had revealed 11 channels with reportable indications. One channel, S04, was replaced, and the other 10 remained in-service following discussions between AECB and Ontario Hydro technical staff and agreement by Ontario Hydro to inspect these channels during the next two scheduled unit outages.

3.5.2 Secondary Systems

Completion of the steam inter-tie line between Units 1 and 2 in the first quarter of 1988 has permitted extension of reactor outages to perform essential maintenance work while minimizing the penalty to Ontario Hydro in power exported from the Bruce site. Each units' turbine generator may now be run up and synchronized with the grid using steam via the tie line from an adjacent units' steam generators. AECB staff has assessed the safety implications of this design change and has reviewed the revised system operating procedures. It is satisfied that the change imposes no significant additional risk to the safety of the public or operating staff.

As a result of the large number of unit cooldowns and warm-ups conducted during 1988, there were many significant events involving steam drum/heat transport piping temperature excursions beyond the limits imposed by the Steam Drum Operating Diagram (SOD) control program. Ten such events were reported. For each case, an analysis was performed to determine whether code allowable stress levels were exceeded. In one case, the analysis determined that this had occurred and a mandatory 100% volumetric inspection of the components (in this case, a 'tee' junction on heat transport piping below the boiler) was carried out. The inspection of the welds and heat effected zones revealed that no damage had occurred. The event that caused this overstressing was due to human error. Maintenance work on a Unit 2 boiler level control valve bypass valve effected the control logic resulting in the flooding of one of the steam drums and a subsequent tripping of the reactor and heat transport pumps. In its review of this event, the station management concluded that it had occurred as a result of a serious oversight by production supervisory staff in not providing adequate guidance to the control technician. AECB project staff agreed with this assessment and saw it as a further example of inadequate supervision of field work and of the sensitivity of the Bruce NGS"A" reactor units to minor process upsets. The transient was exacerbated in this case by the action of the heat transport pumps tripping.

During the Unit 3 outage, fifty-two selected locations in feedwater and steam piping were inspected for evidence of wall thinning as a result of erosion/corrosion. At most locations, some wall thinning was found. It was most severe in feedwater heater vent lines, extraction steam piping and boiler blowdown lines where necessary repairs were affected. AECB staff believes that Ontario Hydro is taking appropriate initiatives at Bruce NGS"A" with respect to erosion/corrosion at the present time.

3.6 Performance of Special Safety Systems

3.6.1 Shutdown Systems (SDS)

At no time during 1988 was SDS1 unavailable on any unit not in the guaranteed shutdown state. SDS2 was reported unavailable four times (twice on Unit 1 and twice on Unit 4) for a total period of 30 hours giving an average unavailability of 0.89×10^{-3} y/yr for the station. Only seven of the fifty-seven (57) significant events reported pursuant to the operating licence in 1988 were attributable to the shutdown systems. However out of 143 events reported, twenty-five (25) were attributable to them. Sixteen of these were completed trips of SDS1 on high rate of increase of power (LOG N) while Unit 1 was in the guaranteed shutdown state.

Ontario Hydro's reports of these events cited 'noise' created by maintenance work in the vicinity of the trip instruments as the cause of the event in nearly all cases. These trips are not considered "safety" significant and Ontario Hydro intend to change the station procedure to require such events to be logged (in the official unit operator's log) at the time they occur and to be reported in a single significant event report at the end of the unit outage.

During the long Unit 3 outage, shut off rod (SOR) #8 was inspected and found to be incorrectly assembled. A spring housing was missing. This error, which had occurred on re-assembly of the Unit in 1982, was undoubtedly responsible for the rod consistently failing to pass the rod drop safety system test. The spring housing was installed, the rod was returned to service and was subsequently successfully tested. AECB staff considers this incident to be a serious one. Not only was a major error made in 1982 but despite clear evidence that something was wrong with the SOR (consistently failing the Safety System Test), nothing was done about it for six years. A new AECB Action Item was raised to identify this concern and to request Ontario Hydro to state their proposed corrective action to prevent recurrence. At the time of writing this action is still outstanding.

The AECB staff report on station operation for 1987 identified as a point of concern the increasing number of shut off rod drop test failures and an AECB Action Item was later raised formally requesting Ontario Hydro to state what action it is taking to monitor and improve the performance of these devices. A test program was undertaken by Ontario Hydro to investigate the high incidence of SOR drop test failure. The tests indicated that a major cause of failure was the erratic performance of a test circuit time delay relay. While AECB staff accepts this evidence, it has observed a definite increase in the frequency at which individual rods have failed to drop in recent years which must have some other explanation. This matter is being pursued as a generic issue with Ontario Hydro. AECB staff has recently approved the replacement of the time delay relays at Bruce NGS"A" with ones of a more reliable design currently in use at Bruce NGS"B".

SDS2 was impaired for 30 hours (inadequate overpower protection) as a result of a reactor core management problem on Unit 4 in November. The impairment occurred when a significant change in neutron flux profile developed in the reactor core following a fuel management error in recalibrating channel power measurements a second time before a previous recalibration had taken effect. The situation was aggravated by the unavailability of the fuelling machines and the delay in execution of an instuction to recalibrate in-core flux detectors.

3.6.2 Emergency Coolant Injection System

The reported unavailability for this system for 1988 was 0.11×10^{-3} y/yr, well below the design target level of 1×10^{-3} y/yr.

A four-hour impairment of the emergency coolant injection system occurred in June when one of the injection valves on Unit 2 was found to be passing and repeated efforts to seat it sufficiently tightly to pass the leak test were to no avail. Malfunction of the valve was found to be due to damage to the valve drive assemblies caused by over-driving them on previous stroke tests. A long standing design change requirement is to replace the drive motors of these valves, which are oversize, with smaller ones and to modify the valve limit switches.

Another event resulting in damage to injection valves occurred in September. While drilling a hole through a concrete block wall, a service maintainer cut through a hidden cable tray and drilled into a live multi-conductor control cable. The shorting that occurred between adjacent conductors caused two Unit 3 injection valves to drive open and closed numerous times in an uncontrolled manner resulting in severe damage to the valves. Fortunately, the unit was in the guaranteed shutdown state at the time of the incident. AECB staff has reviewed this event and is satisfied that Ontario Hydro is taking appropriate remedial action.

3.6.3 Negative Pressure Containment

Due to an event in which containment activity monitors were found to have been moved, at some point during construction work, from their normal location, the system was declared unavailable for a duration of 94 days. This resulted in an unavailability level of 266.5×10^{-3} y/yr for the system in 1988 grossly exceeding, once again, the reliability target of 1×10^{-3} y/yr unavailability.

Negative pressure, in-service containment leak tests carried out on four occasions during the year showed that the leak tightness of the system was, at times, slightly in excess of the 2% vol/hr design limit assumed in the safety analysis. In addition, instrument air inleakage was substantially above the design limit of 208 kg/hr. Although Ontario Hydro claims that a leak of 3% mass/hour would not exceed the single failure dose limit in the event of an accident and that much higher air inleakage rates can be tolerated, at the time of writing, AECB staff has not yet received satisfactory evidence to support these claims.

Installation and commissioning of hydrogen ignitors in all unit vaults was completed in 1988. They are presently available for "manual" operation and require completion of additional wiring to operate automatically. This design feature was provided to reduce the risk of hydrogen explosions inside containment.

Section 4.3 summarizes the progress made by the licensee on various other containment improvement projects.

3.7 Significant Events

During 1988, no serious process failures were reported. Of the one hundred, forty-three (143) significant events reported, fifty-seven (57) were pursuant to the Bruce NGS"A" operating licence. This represents, once again, a significant increase over the reportable events recorded in 1987 (36). A comparison of events for the two years shows where the increases have occurred.

Event Category	Number of Reportable Events 1987	1988
Radiation Control	10	15
Shutdown Systems	6	7
Containment	1	5
Emergency Cooling Injection	1	1
Reactor Process Systems	10	16
Secondary Systems	5	8
Miscellaneous	3	5

While the reason for the increase in the number of reportable events in nearly all categories is not obvious to AECB project staff, the increased level of maintenance on process systems and larger number of unit shutdowns and restarts in 1988 compared with 1987 are believed to be contributing factors. Appendix I lists the significant events pursuant to the licence.

The number of events in which human error was a contributing factor is a little lower than in 1987 (69 compared with 72). As a fraction of the total number of events reported, the drop appears more significant (48% compared with 62%). AECB project staff considers that this change outweighs the increase in the number of reportable events and reflects a slight improvement in the quality of work in the plant.

Based on their review of significant events, AECB staff is in agreement with the "unavailability" values reported by Ontario Hydro for the special safety systems. (These values appear in Appendix 2 of this report under section 2. Plant Control.)

Events considered to be of most significance are discussed in subsections 3.3, 3.5, and 3.6 of this report under headings that correspond with the event categories.

As was noted in section 3.1.2.2, nine event in 1988 were designated contraventions of the operating policies and principles (OP&P). A brief summary of these events follows:

1. January 1988 - Two standby Class III generators were out-of-service and two were running. One of the running SGs tripped on a high temperature signal from a faulty thermocouple, leaving only one standby generator (SG) running for approximately 30 minutes. OP&P requires a minimum of two SGs to be available when three reactor units are in operation.

2. March 1988 - The end shield cooling system on Unit 1 was partially drained for equipment maintenance before it was realized that OP&P requires that the system shall be kept full to avoid high thermal stresses in the calandria.

3. May 1988 - Moderator level rose and moderator cover gas pressure fell when Unit 4 valving was being retuned to normal after a containment pressure test. This caused the helium injection header of SDS2 to flood for a few minutes before normal conditions were restored. OP&P requires that moderator level be controlled at all times to prevent this from happening.

4. September 1988 - Work to install the new "P Trip" system was performed in an unapproved and unsafe manner. The work involved wiring changes associated with SDS2 and violated OP&P requirements for maintenance work on shutdown systems.

5. November 1988 - Moderator level rose to flood the SDS2 helium injection header when the main moderator pumps were shutdown during an outage of Unit 1.

6. November 1988 - This event involved the moving of containment activity monitors for the Unit 3 vault vapour recovery system from their normal location by persons unknown causing an impairment of the containment system and violating the OP&P requirements for maintenance work on containment systems.

7. December 1988 - Due to an operator error, the fuel supply to the standby generators remained shut-off for approximately 7 days. During this time, OP&P requirements were violated on two counts:

   i) the remaining two generators were not run continually
   ii) one of the remaining generators became unavailable for several hours.

8. December 1988 - Flooding of SDS2 helium injection header occurred again, this time due to the isolation of the vent paths from calandria level control valves.

9. December 1988 - Event similar to 6. above.

The above events have been reviewed by AECB project staff, and the corrective actions proposed by Ontario Hydro, most of which have now been implemented, are considered adequate. At the time of writing, investigations are still underway into finding an appropriate solution to the problem of SDS2 helium injection header flooding. AECB staff regards this as a potentially serious problem.

3.8 Quality Assurance

There were two quality assurance (QA) audits conducted by AECB staff during 1988. The first audit, carried out in February, covered operating practices in the plant but avoided areas where Ontario Hydro was known to be in the process of implementing measures to correct known deficiencies. Problems were identified in the areas of safety system call-ups, jumper records, shift turnovers, measurement and test equipment calibration, and operator routines. The second audit, carried out in December was confined to fuel handling. Problems were identified in the areas of control room operating procedures, administration of jumpers, work reports, shift turnovers, work plans, access control and software change control. The first audit showed that significant improvement was not achieved by many of the Ontario Hydro corrective actions implemented in an effort to resolve problems identified in the Fall 1986 AECB Assessment of Operating Practices. The second audit showed that actions taken by the station to resolve some of the problems identified by the first audit in 1988 had also been ineffective in the fuel handling areas audited.

An audit conducted by AECB staff at the end of the first quarter 1989 covering most of the functions audited in February 1988 showed significant improvements in all of the report audit areas except for "jumpers".

A draft second revision of the Bruce NGS"A" Quality Assurance Manual was issued in September. AECB project staff expressed its dissatisfaction with some of the contents of this manual and, in particular, with the indicated low level of authority of the manual. Ontario Hydro has promised to address these concerns and AECB staff has agreed with a proposed rewording of the "Foreward" of the manual that identifies the manuals' authority with respect to other Bruce NGS"A" station documents.

At the time of writing, Revision 2 of the station QA manual has not been issued.

A proposed change to the station organization was submitted formally to the AECB in October for approval pursuant to the licence. A reduced size QA section was indicated (later determined to be a proposed reduction in staff complement from four to two). The proposed organization change was approved by AECB staff with the exception of the reduction in size of the QA section.

The proposed change includes the addition of four new Technical Superintendents to assume the following responsibilities:

2 for Production Section (reporting to Production Manager)

1 - Technical Superintendent - Maintenance
1 - Technical Superintendent - Unit Outages

2 for Technical Section (reporting to Technical Manager)

1 - Technical Superintendent - Chemistry, Metallurgy, Physics and Environment
1 - Technical Superintendent - Equipment and Documentation

AECB staff considers these additions to the station organization as a positive step and one that is likely to increase the effectiveness of the station's Quality Assurance program.

At the time of writing, AECB staff is reviewing the licensee's rationale for the reduced role of the station QA section which is a generic position. In the case of Bruce NGS"A" only, it is now proposed to have a staff complement of three and not two, as for other stations, in the QA section. However, this has been approved for 1989 only.

AECB project staff remains concerned that Ontario Hydro does not appear to regard a formal quality assurance program as important to the safe operation of nuclear power plants.

3.9 Station Maintenance

Section 3 of the Objective Measures of Station Performance shows that there is a slight increase in the number of outstanding call-ups and DRs (Deficiency Reports) compared with the previous year. These increases can probably be attributed to manpower shortages, particularly in the control maintenance area which accounts for between 50 and 60% of the backlog of DRs and call-ups. Increased surveillance of the plant by the newly introduced operator "rounds" program has also contributed by increasing the number of deficiency reports being raised. The increase in unit outage time in 1988 compared with the previous year resulted in a heavier breakdown maintenance workload for all maintenance work groups, diverting manpower from routine call-up and DR work.

Further comments on station maintenance are included in Section 4.5.

3.10 Chemistry

As mentioned in last year's report, poor chemistry control is inconsistent with paragraph 2.4 of Operating Policies and Principles. In 1988 chemistry results continued to fall short of Ontario Hydro's targets. However, substantial administrative measures are being taken to strengthen management of the chemistry section and to improve staffing levels, monitoring capability, and procedures. It remains to be seen whether these measures will result in practical improvements.

AECB staff is anxious to see an improvement in performance in this area because the future safety implications of continued operation with out-of-specification chemistry are not predictable.

3.11 Station Management

Despite an increase in unit outage work load and a continuing shortage of staff, a significant improvement in the management and control of station operation was observed by AECB project staff in 1988. A major effort has been made by station management to solve identified problems and to improve the quality of station operation. As a result of these efforts, improvements were evident, at the end of the year, in a number of areas, such as planning and administration of maintenance work, technical unit review of call-ups, control of flowsheets, operator routines and "rounds".

The 1987 initiative of the station manager to have installed inter-unit steam tie-lines had a positive impact in 1988 in permitting longer reactor outages to perform important maintenance work.

A plant inspection program initiated by station management in January 1988 and continued through the year was effective, although the completion rate for scheduled inspections dropped off towards the end of the year. This program required that all of the station's managers and superintendents tour designated areas of the plant and prepare inspection reports identifying housekeeping actions. AECB project staff has observed a distinct overall improvement in housekeeping standards, although lapses still occur.

AECB staff has continued to receive good cooperation from, and has maintained open communication with, Ontario Hydro station staff at all levels. Advance notification of potential licensing issues and prompt notification of safety significant events or activities has been consistently provided by station management. This advice has been appreciated by AECB project staff.

Areas in which AECB staff considers improvements are necessary are:

i) control of quality of maintenance work and field operations
ii) timeliness of issue of operating manual revisions[1]
iii) timeliness of issue of significant event follow-up reports
iv) administration and control of jumpers

While there is evidence that station management is taking steps to effect improvements in these areas, AECB staff considers that more effort is required to achieve higher standards sooner.

3.12 Training

Bruce NGS"A" shift supervisor and first operator candidates recorded a small increase in their pass rates for AECB examinations in 1988 over the previous year. Although this is an improvement, it is the opinion of AECB staff that better results could be achieved if the quality of operating procedures and training manuals were improved.

AECB staff is not able to comment with any authority on the training of operations and maintenance staff in general due to lack of objective evidence. It is hoped to conduct an assessment of this training program in the future.

Ontario Hydro is developing a program for continuation training for authorized personnel (Reactor First Operators, Shift Supervisors and Shift Operating Supervisors). AECB Staff is of the opinion that this process should be accelerated.

Note 1: It should be noted that a major improvement was made in the timeliness of review of operating memos. In 1987, seventy-three operating memos were behind schedule for review at the end of the year, and in 1988, only fifteen were behind schedule.

3.13 Emergency Drills

In 1987, AECB staff criticized station performance of only 73% of planned emergency drills completed. For 1988, the figure is 100% which is highly commendable. AECB staff has observed some drills, particularly a major Ontario Hydro corporate exercise, in which Bruce NGS"A" played a lead role, and was impressed by the competence and enthusiasm of the Bruce NGS"A" staff. Intended strengthening of the Emergency Preparedness group should assist in maintaining this good performance.

3.14 Security

There were no security incidents during 1988. Plant security is considered to be satisfactory by AECB staff.

3.15 AECB Staff Inspections

AECB project staff stationed at Bruce NGS"A" performed routine rounds inspections during 1988 of all inside areas of the plant where unit systems and equipment are located. The inspections revealed a noticeable improvement in housekeeping standards and general state of equipment as the year progressed. However, it is the opinion of AECB staff that housekeeping standards are not yet entirely satisfactory. More effort is required on the timeliness of clean-ups after work involving portable equipment, consumables, and special clothing and clean-ups of fluid leaks and spills. In addition, while the inspectors observed an improvement over the year, radiation survey signs were not being maintained sufficiently current in many areas of the plant. After initiation of the operator "rounds" program, a noticeable improvement was observed in the identification of equipment deficiencies with Deficiency Report tags.

3.16 Measures of Station Performance

Appendix II provides a list of 1988 performance indicators and other objective measures which are compared with 1987 values and are assessed by AECB staff as "acceptable" or "needs action". Most of the indicators and measures are commented on in the appropriate section of the text of this report. It should be noted that the assessment of "satisfactory" or "needs action" is not based on any established criteria but represents a "consensus" view of AECB staff members who were most closely involved with the operation of the plant in 1988.

4. SIGNIFICANT LICENSING MATTERS AND ACTIVITIES

4.1 General

The major issues mentioned in section 3.2 of last year's report continued through 1988, and are reviewed below.

4.2 Primary Heat Transport Pump Trips

Ontario Hydro was required, by a licence condition imposed in January 1988, to install by 30 September 1988, an AECB approved, permanent system to automatically trip the primary heat transport pumps in the event of conditions arising which might allow the pumps to induce severe vibration of the reactor cooling pipework and might endanger the containment boundary seal around the pumps themselves. During the first half of 1988, AECB staff closely monitored Ontario Hydro's progress with the pump trip design and expressed reservations regarding the overall reliability of the proposed system and with respect to the employment of a standard commercial microprocessor, in particular. Ontario Hydro did not formally present its design until early August and proceeded with installation and commissioning of the system, while considering various design changes. On 27 September 1988, Ontario Hydro requested an amendment to the licence condition to allow installation by 31 March 1989.

This request was refused by the AECB and all four reactor units at Bruce NGS"A" were shut down by 30 September 1988.

Subsequently, Ontario Hydro proposed significant design changes and a much improved project management organization. Some additional analytical work was undertaken and some practical steps were taken to limit the potential for pump vibration including the construction of massive pump support structures. On this basis, the AECB amended the licence and allowed the Bruce units to restart. Ontario Hydro met its second installation deadline by having an approved trip system installed on running reactor units by 31 March 1989. The utility also conducted a high level investigation which has made a number of recommendations aimed at the prevention of future circumstances that might lead to such regulatory action. Further details of these events are contained in Board Member Documents (BMDs) 88-139, 88-139A, and 89-62.

4.3 Containment Modifications

During 1988, Ontario Hydro made progress with committed improvements to the Bruce NGS"A" containment system. Additional automatic isolating dampers were installed on the vault vapour recovery system (the major source of leakage) although installation of the controls to permit automatic operation of the dampers is still outstanding. Commissioning of instrumented pressure relief valves was essentially completed, a program to reduce the consequences of containment door seal failure was completed, and the new emergency filtered air discharge system (EFADS) was commissioned. To its credit, Ontario Hydro volunteered a station outage in May 1989 to conduct a leakage test at design pressure in order to confirm that measures taken to reduce containment leakage have been effective.

However, AECB staff still has reservations as to the effectiveness of EFADS and of its associated instrumentation. Ontario Hydro is aware of several deficiencies in the system and is making plans to rectify them.

4.4 Pressure Tube Integrity

This issue has become more generic to all CANDU reactors than specific to Bruce NGS"A". During 1988, Ontario Hydro met its commitments with respect to pressure tube inspections at Bruce. No unexpected results were reported. Further details of the inspections carried out are included in section 3.5.1 of this report.

4.5 Standards of Operation and Maintenance

As a result of a number of assessments of operation and maintenance practices at Bruce NGS"A" made since 1986, AECB staff came to the conclusion that standards in these areas were only marginally satisfactory, although showing signs of improvement, at the time of Bruce NGS"A" Reactor Operating Licence renewal in October 1988 (see BMDs 88-139 and 88-139A). In the course of arriving at its decision to renew the license, the Board invited the Bruce NGS"A" station manager to present his views on this topic. He was accompanied by Ontario Hydro's Director of Nuclear Generation Division. A presentation was made that recognized problems at Bruce NGS"A", explained Ontario Hydro's intention to regain excellence in its operation, and provided details of a major staff recruiting program. It was stated that Ontario Hydro had rectified or was in the process of rectifying many of the deficiencies identified by the AECB and by its own auditors but that some areas would be difficult to address in the short term (one-two years) until additional, trained human resources had been acquired and until certain negotiations, with respect to supervision, had been completed with the employee's union. Accordingly, it was not possible to make quantifiable commitments covering specific improvements to be made in the next twelve-month licensing period, but the AECB would see evidence of Ontario Hydro's commitment through actions to reorganize, recruit staff, improve supervision, training and to adopt better administrative processes. The Board decided to renew the Bruce NGS"A" Reactor Operating Licence for one year only and formally advised Ontario Hydro that subsequent licence renewal would be contingent on the Board seeing satisfactory evidence of improvements in the operation and maintenance of the station. AECB staff is conducting an on-going assessment in this area.

AECB project staff was encouraged to observe the development of an effective review process during 1988 for improving the management of the maintenance work backlog. The process involves a technical assessment of each outstanding work item and the assignment of a priority classification, based on safety and production considerations, that established its execution priority. AECB project staff believes that the consistent application of this process will significantly reduce the risk of major equipment failure. However, without an increase in maintenance staff resources (particularly in control maintenance), the backlog could become unmanageable.

Approximately 16% of the 143 significant events reported in 1988 were caused, or contributed to by, maintenance errors. AECB staff is of the opinion that inadequate field supervision and ineffective verification of work were the main reasons for this high figure. Similar conclusions were drawn in last year's report. The situation does not appear to have improved significantly. The serious event involving flooding of a steam drum and overstressing of heat transport piping discussed in section 3.5.2 could have been prevented had the control maintenance work on boiler level control been properly planned and supervised.

It was noted that a new temporary operator shift organization took effect on March 1, 1989. This new organization includes the addition of two field supervisors on each shift crew, each of whom is responsible for supervising field work on two units. Early indications are that this change is effective in improving the quality and quantity of operator field work and the turnover process between field operators at shift change. It is to be hoped that the field supervisor position will become a permanent position in the station organization.

Despite the proposed reduction in staff complement of the QA section, AECB staff believes that the implementation of the other proposed changes in the station organization, referred to in section 3.8, and the significant increase in station production staff numbers now committed by Ontario Hydro will result in an overall improvement in the quality of operation and maitnenance work.

5. CONCLUSIONS

AECB project staff believes that overall performance of the station in 1988 was generally satisfactory and better than in 1987. However, this assessment is not supported by some of the key performance indicators, although the indicators in areas where AECB staff had specific concerns do support it. For example, the percentage of reported significant events attributable to human error, the number of operating memos beyond the review date, scheduled emergency drills completed, the number of completed reactor trips all show a significant improvement over the 1987 value. In addition, AECB staff has been encouraged by the licensee's implementation of effective review processes for operator and maintenance call-ups, routines and deficiencies, and the establishment of supervisor inspection tours and operator "rounds" programs. Nevertheless, it is the opinion of AECB staff that to achieve standards of operation which would be considered fully satisfactory, the backlog of maintenance work must be reduced, the quality of work performed in the plant improved, and assurance provided that the required quality standards are being consistently achieved and maintained.

Appendix I

1988 SIGNIFICANT EVENTS PURSUANT TO THE OPERATING LICENCE

Number	Title
88- 1	SDS1 Trip - Heat Transport Low Pressure and Steam Drum Temperature Differential
88- 3	Loss of Production and Moisture Separation Steam Leak
88- 4	Violation of Work Protection Code - Near Miss Breach of Containment
88- 5	Less than Required Number of Standby Generators Running
88- 11	Unit Alert (4) High Tritium Levels Around Drier #1
88- 23	Unit Alert - Moderator Cover Gas Leak
88- 27	Inadvertent Fuelling of Fuel Channel O10 Unit 4
88- 28	Draining of Endshield Cooling
88- 31	PTrip Impaired and Blocking Switch Impaired
88- 52	Loss of Instrument Air Compressors
88- 55	Primary Heat Transport Pump Secondary Seal Failure
88- 57	Steam Drum Danger Limit Exceeded
88- 58	3312 Pump #1 Secondary Seal Failure During Heat-up
88- 61	Failure of Heat Transport System Pump #1 to Trip
88- 63	Conditioning Not Reset - Heat Transport System Low Pressure
88- 64	Station Alert - Contamination Elevation 591, Units 1, 2, 0
88- 66	Loss of Moderator Cover Gas Pressure
88- 67	Station Alert - Loose Contamination on 591 Elevation, Units 0, 1, 2
88- 68	Special Category Impairment: Motorized Valves 3433-MV15 Passing
88- 69	Station Alert - Contamination in Units 1, 2, 0

88- 73	Loss of Heat Transport Feed During Unit Cooldown
88- 74	Unit Alert - High Tritium in Air
88- 75	Breach of Containment - Airlock 2 Equipment Door Partially Deflated
88- 76	Moderator D_2O Spill
88- 77	Near Miss Event - Failure of Access Control
88- 78	North Fuelling Machine Powertrack Damage
88- 79	Cable Tray Fire in Unit 0: Unit 1 Shutdown
88- 80	Loss of Production and Steam Leak on Line to Steam Transformer Plant A
88- 81	Moderator Cover Gas Excursion
88- 82	Unit Alert - Flange Leak, Moderator Upgrader Pump
88- 83	Deaerator Storage Tank Outlet Nozzle Cracks
88- 85	Unit 0 Alert - Auxiliary Service Building D_2O Spill
88- 86	Moderator D_2O Leak in Auxiliary Service Building
88- 88	D_2O Spill at Discharge of Moderator Reflux Pump, 3843-P8
88- 94	Steam Drum #2 System Operating Diagram Danger Alarm Point Exceeded
88- 95	Level 1 Impairment of Heat Transport Pump Trip Logic
88- 96	Broken Weld on Shutdown Cooling Circuit Drain Line
88- 98	Failure to Install Neutron Overpower Trip at Low Power
88- 99	Unit Alert - High Tritium Levels at D_2O Vapour Recovery Dryers
88-100	System Operating Diagram Danger Alarms During Unit Partial Loss of Class IV Power
88-104	Heat Transport System Leak at Check Valve 3331-NV17
88-105	Unapproved Method of Shutdown System 2 Maintenance
88-106	Unit Alert - D_2O Spill
88-111	Pressurization of Heat Transport System Without Appropriate Approvals (Annulus Gas System Unavailable)

88-112	Heat Transport System High Pressure Trip During Unit 4 Three Pump Start-up
88-114	Hot Spot Contamination
88-115	Damage to CIGAR System (pressure tube inspection equipment)
88-120	Partial Blockage of Annulus Gas System
88-121	Unit Alert - Tritium Hazard
88-127	Level 2 Impairment of Shutdown System 2 Due to Flooding of The Injection Header
88-129	Impairment of Containment Activity Monitors
88-130	System Operating Diagram Danger Alarm Exceeded
88-132	Breach of Containment - Level 2 Impairment
88-134	Standby Class 3 Impairment - Unavailability of 2 Standby Generators
88-135	Impairment - High Table Number
88-140	High Activity Monitors Removed from Normal Vault Vapour Recovery System Location
88-141	Level 2 Impairment of SDS2 Due to Flooding of the Injection Header

APPENDIX II

BRUCE NGS'A'

OBJECTIVE MEASURES OF STATION PERFORMANCE - 1988

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
1. Radiation Control				
1.1 Occupational Safety				
1.1.1	Total Whole Body Dose 5.2 Pers.-Sv (522 Pers-rem)	5.5 (547)	[X]	[ ]
1.1.2	Total Extremity Dose 5.5 Sv (551 rem)	7.6 (759)	[X]	[ ]
1.1.3	Total F/H Extremity Dose 1.4 Sv (137 rem)	2.1 (212)	[X]	[ ]
1.1.4	Total Neutron Dose 1.1 mSv (.115 rem)	.6 (.065)	[X]	[ ]
1.1.5	Number of Exposures > Regulatory Limits 0	0	[X]	[ ]
1.1.6	Number of Radiation related supervisor's investigations 43	47	[ ]	[X]
1.2 Public Safety				
1.2.1 Releases from the Station				
	a) Airborne			
	Tritium No of weeks >1% DEL 2 Average % DEL for year .55%	5 .56	[X] [X]	[ ] [ ]
	Noble Gas No of weeks >1% DEL 1 Average % DEL for year .61 %	1 .61	[X] [X]	[ ] [ ]
	Iodine 131 No of weeks >1% DEL 0 Average % DEL for year .019%	0 .002	[X] [X]	[ ] [ ]
	Particulates No of weeks >1% DEL 0 Average % DEL for year .012%	0 .01	[X] [X]	[ ] [ ]

1.2.1 Continued		LAST YEAR'S VALUE		ACCEPTABLE	NEEDS ACTION
b) Waterborne					
Tritium	No of months >1% DEL 0	0		X	
	Average % DEL for year .33%	.24		X	
Gross ß	No of months >1% DEL 1	0		X	
	Average % DEL for year .55%	.16		X	
c) Total Heavy Water Loss 19202 kg (if excessive, should be reflected in higher tritium releases)		18284		X	
1.2.2 Environmental Measurements					
Average Boundary dose rate 55 nGy/h (5.5 µR/h) (Acceptable if within range of provincial reference sites value and not a significant increase from previous years)		54	nGy/h (5.4)	X	
Average Boundary Tritium in Air 0.044 %MPCa (> .1% MPCa would indicate a marked increase and would require investigation)		.048		X	
Average Tritium Concentration in Precipitation 440 Bq (11.9 nCi/l) (average of all measurement sites)		311	(8.4)	X	
Average Gross ß in Precipitation 28 MBq.km^{-2}.months^{-1} (0.76 mCi.km^{-2}.mo^{-1})		28	(.75)	X	
Average Tritium in Milk 18 Bq/l (500 pCi/l)		27	(733)	X	

1.2.2 Continued

			LAST YEAR'S VALUE		ACCEPTABLE	NEEDS ACTION
Average C14 in Milk	240 Bq/g of C	(6.5 pCi/g of C)	233	(6.3)	X	
Average I131 in Milk	141 Bq/1	(3.8 pCi/1)	141	(3.8)	X	
Average Tritium in drinking water	26 kBq/1	(715 pCi/1)	31	(836)	X	
Average gross B in drinking water	85 Bq/1	(2.3 pCi/1)	63	(1.7)	X	
Local water and fish samples					X	

Specific items for comment:

NO COMMENT.

Terrestrial Samples X

Specific items for comment:

NO COMMENT.

2. Plant Control

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
2.1	Number of Completed Reactor Trips/Unit 1.5	2.25	☒	☐
2.2	Number of Serious Process Failures/Unit 0	0	☒	☐

2.3 Special Safety System Unavailability (10^{-3} Years/Year)

	This Year					Last Year						
	U0	U1	U2	U3	U4	U0	U1	U2	U3	U4	ACCEPTABLE	NEEDS ACTION
SDS1		0	0	0	0		0	0	0	0	☒	☐
SDS2		.11	0	0	3.44		.052	0	0	0	☐	☒
Containment		266.5	266.5	266.5	266.5		385.6	385.6	385.6	385.6	☐	☒
ECI		0	.43	0	0		0	0	0	0	☒	☐

2.4	Number of Reportable Incidents/Unit	14	10	☐	☒
2.5	Number of fires	7	7	☒	☐
2.6	Number of Significant Events with Human Error Contribution (for all units)	69	72	☐	☒

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
3. Plant Maintenance				
3.1 Number of Call-ups (C1,K1,M1) Outstanding at end year	579	518	☐	☒
3.2 Average of Monthly DRs Outstanding/Unit	1125	935	☐	☒
4. Plant Administration				
4.1 Documentation				
4.1.1 Average No. of Op Memos in force/unit on 31 December	66	58	☐	☒
4.1.2 No. memos extant > 6 months	111	69	☐	☒
4.1.3 No. of systems (USI) with >1 Op. Memo Extant	32	32	☐	☒
4.1.4 No of Operating Memos behind schedule for review	15	73	☒	☐
4.2 Training				
4.2.1 % Scheduled drills completed	100	73	☒	☐
4.2.2 % Candidates passing AECB exams	79 (75 rad.prot.)	76 (50)	☒	☐

4.3 Security		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
4.3.1 Number of reportable security events	0	0	[x]	[ ]

4.4 Quality Assurance (See Section 3.8)

4.4.1 Results of AECB Audits			
1) Date Feb '88 - Operating Practices	[ ]	[x]	
2) Date Dec '88 - Fuel Handling Operation and Maintenance	[ ]	[x]	
3) Date _____	[ ]	[ ]	
4.4.2 AECB Assessment of Station Quality Assurance Manual	[ ]	[x]	